8806. a 41

THE DESCRIPTION AND USE OF DONN'S IMPROVED NAVIGATION SCALE.

K

LONDON:
Printed by Sabine and Son, Shoe Lane,
Fleet Street.

BRITISH MUSEUM

As in all Books of Navigation, the Uſe of the common Gunter's Scales are deſcribed, and alſo known to the generality of Teachers, it is preſumed, that a Deſcription and Uſe, merely of the particular Additions and Alterations, will be fully competent to the perfect Comprehenſion of the ſuperior Uſefulneſs of Mr. Donn's Scales.

To diſtinguiſh this Scale from others, the Book will not be ſold ſeparate.

THE DESCRIPTION & USE OF THE IMPROVED NAVIGATION SCALE.

THE defects of the common Gunter's ſcale, induced Mr. Benjamin Donn to contrive the one deſcribed in the following pages; which, to any perſon ever ſo little acquainted with navigation, will appear to poſſeſs both valuable and eſſential improvements; their *uſes*, alſo, will be to them very evident: but for the ſake of the young nautical ſtudent, a conciſe deſcription will be indiſpenſably neceſſary; part of which is in Mr. Donn's own words—On that ſide of the ſcale which has the bevel edge, are the following ſcales:

1. A ſcale of 24 inches divided into *tenths* of an inch. Over the beginning of the inches are ſeveral ſmall braſs pins with figures annexed, ſhewing weight of the ball to any diameter of the gun. Example. If the diameter of the bore of a gun

be 5 inches 3 tenths, it ſhews, by inſpection only, that ſuch a bore will carry 18 pound ſhot. It is known to ſailors, that the weight of powder for ſervice is generally half the weight of the ſhot.

2. Under the above line of inches, a foot is divided into 100 equal parts; ſo again, by inſpection, inches may readily be turned into the decimal parts of a foot; or, on the contrary, the decimals of a foot turned into inches. In menſuration, this ſcale is very uſeful, as diviſions may be taken in feet, and the decimal parts inſtead of feet and inches. Hence the content of any piece of timber, &c. may be found by common multiplication. Example. If a plank is 20 feet long, and 1 foot 50 hundredths broad, the 1,50 multiplied by 20, gives 30 feet, the content required. *This line is not on the common ſcales.*

3. As in many ſchemes which are to be plotted, ſcales of equal parts, containing different *numbers of parts* to an inch, are frequently wanted; ſo, to retain theſe, the diagonal ſcale has been rejected, to the no ſmall inconvenience of the menſurator, to give room for theſe plotting ſcales: but, in this improved ſcale, the diagonal, which is ſometimes preferable on account of its accuracy, is ſtill preſerved on the ſcale, and different ſcales of equal parts are added at the bottom, marked 25, 30, 35, 40, 45, 50, and 60, ſignifying 25, &c. parts to an inch, making, with the diagonal, a compleat ſet,

as

as that contains, from its principle, 10 and 20 to an *inch*.

4. This ſide of the ſcale contains, likewiſe, the line of rhumbs, chords, ſines, tangents, &c. as on the common ſcales; alſo two correſponding lines; one marked *M. LONG*, the other *CHORD*; by which, is ſhewn by inſpection, how many miles, in any latitude make a degree of longitude. Example. Againſt 70 degrees of longitude on the *Chord*, you will find on *M. Long* that 21 miles make a degree of longitude, in that latitude.

As Mr. Donn obſerves—"Nothing farther need be ſaid to explain this ſide of the ſcale, to thoſe who are acquainted with the uſe of the common ſcales;" and in reſpect to the other ſide, known by the name of Gunter's, (from the logarithms of numbers, ſines, and tangents being firſt laid thereon by Mr. Edward Gunter) the extenſive *uſefulneſs* of theſe lines are too well known, to need a particular deſcription here; but as this deſcription is intended to explain thoſe things, in which this ſcale differs from others, a word or two will be neceſſary—Firſt, hinting to the young nautical ſtudent, that *To work a cannon, or proportion on Gunter's ſcale, who have only to extend the compaſſes from the firſt term to the ſecond on the proper line, then will the ſame extent, laid the ſame way from the third term, viz. from the left to the right, or from the right to the left, according as the ſecond term lay from the firſt, give on its proper line the fourth number required.*

As in the common rule of three it is no matter which of the two middle terms are placed firſt, ſince the product is the ſame; ſo, in working on the Gunter's ſcale, if at any time it is found more convenient, we may extend the compaſſes from the firſt term, in the proportion, to the third term; then will that diſtance extend from the ſecond term to the fourth, or required term.

In counting on the line of numbers, it may be proper to remark, that the numbers 1, 2, 3, 4, &c. repreſent not only 1, 2, 3, 4, &c. but 10, 20, 30, &c. Thus if the cannon, a proportion you are working, requires you to call the 1 in the middle of the line of number 100, then muſt the 2, 3, 4, 5, 6, 7, 8, 9, 10, on the right hand be called 200, 300, 400, 500, 600, 700, 800, 900, 1000; the 9, 8, 7, 6, 5, 4, 3, 2, 1, on the left, be called 90, 80, 70, 60, 50, 40, 30, 20, 10.

If the 1, in the middle of the line, be called 1000, the figures 2, 3, 4, &c. on the right, will be 2000, 3000, 4000, &c. and 9, 8, 7, 6, &c. on the leſt, 900, 800, 700, 600, &c.

Again. If the 1 in the middle be called 10, the figures 2, 3, 4, &c. on the right hand, muſt be 20, 30, 40, &c. and on the left, 9, 8, 7, &c. will be only 9, 8, 7, &c.

Alſo, if the 1 in the middle be called 1, then 2, 3, 4, &c. on the right hand, will ſtand for 2, 3, 4, &c. but 9, 8, 7, 6, &c. on the left, will be only $\frac{9}{10}$, $\frac{8}{10}$, $\frac{7}{10}$, &c.

To refreſh the memory of the young learner, the cannons, in common uſe for working a day's work, are ſtamped on the ſcale. The R : DIST : : SC : Dep : SCC : D LAT. ſignifies, that as radius is to the diſtance, ſo is ſine of the courſe to the departure; and ſo is ſine complement of the courſe to the difference of latitude.

Again. D. LAT : Dep : : tangent 45 : T. courſe, is as difference of latitude is to the departure, ſo is tangent of 45 degrees to the tangent of the courſe.

Alſo, SC Mid LAT : Dep : : R : D LONG, is to be read as ſine complement of the middle latitude is to the departure; ſo is radius 90 degrees, to the difference of longitude. Or to find the difference of longitude by meridional parts; D LAT : Dep : : MD LAT : D LONG, which is to be read, as difference of latitude is to the departure, ſo is the meridional difference of latitude to the difference of longitude.

Laſtly. SCL : S ⊙ Dec : : R : S ⊙ AMP. is to be read as ſine compliment of the latitude is to the ſine of the ſun, or ſtars, &c.'s declination, ſo is radius, or ſine of 90 degrees, to the ſine of the ſun's, &c. true amplitude.

The *firſt line* on the *Gunter's ſide* is marked *S. RUMB*, that is, ſines of rumbs, or courſes.

The *ſecond line* is marked *NUMB Sqr.* and is the common line of numbers intended to be uſed with the ſines, or tangents, &c. In working the uſual

uſual cannons in trignometry or navigation, it is marked *NUMB Sqr.* becauſe, with the line marked *NUMB Root,* it will ſerve for ſquaring numbers, &c. of which farther notice will be taken preſently.

The *third line,* marked S. (CS) Sec. is the common line of ſines, with the addition of being numbered backwards, by ſmaller figures; by which addition it now ſerves the ſeveral purpoſes of a line of *ſines, co-ſines,* and ſecants. A notion has very much prevailed among ſome teachers of trignometry and navigation, that if a ſecant was in the proportion, it could not be ſolved by the ſcale. Nay, two writers on navigation have poſitively affirmed, that *if in the cannon, or proportion, there is a ſecant, the operation cannot be performed by the ſcale*; but that they are miſtaken, may be readily ſhewn by only working one example. Let us ſuppoſe the angle A, or the angle at the baſe of a right angled triangle, to be given equal to 50 degrees, and the baſe 86 yards, to find the hypothenuſe. If the baſe be made radius, the cannon is, as radius is to the baſe 86, ſo is ſecant of the angle A 50 degrees, to the hypothenuſe. This may be worked on the ſcale thus: Extend the compaſſes from radius, or 90 degrees to 50 degrees on the ſame line, (of ſines) counted backwards from radius, by the ſmall figures, for the ſecant; then, one leg of the compaſſes being ſet at 86 on the line

line of numbers, that extent will, turned the contrary way, (becauſe the ſecants are ſuppoſed to run beyond the ſcale) reach to 134, the diſtance which was required.

The *fourth* and *fifth lines* are the verſed ſines, and tangents, as on the common ſcales.

The *ſixth* is the meridian line, which, on the common ſcales, is too ſhort to be of much ſervice; but by making on two lines, as done here, we are enabled to go from 30 to 80 degrees of latitude, and yet have the degrees ſufficiently large to divide the meridian of Wright's chart into every 10 minutes, or leſs parts. The length of the degrees of the equator, correſponding to thoſe of the meridian, are annexed on the left hand, and marked Eq. Deg.

The meridian lines being conſtructed by the diagonal ſcale of 20; if at any time, in the abſence of tables, we are inclined to know nearly the meridional difference of latitude between any two places, we have only to take the diſtance between the two latitudes, from the meridian line on the ſcale, then meaſuring the diſtance on the diagonal ſcale of 20, we ſhall have nearly the meridional miles required. Thus, for example. If it was required to find the meridional difference of latitude, between the latitudes of 20 and 30 degrees, the diſtance between theſe degrees taken from the meridian line, will, on the leſſer diagonal al ſcale, meaſure 663, reckoning each primary diviſion, or half inch, 100 miles, for the meridional difference of latitude.

The *ſeventh* and *eighth*, or two remaining lines of the ſcale, are a *ſingle* and *triple* line of numbers, marked *Numb Root*, *Numb Cube*, which, together with the ſecond line, or double line of numbers, marked *Numb Sqr.* are for *ſquaring* or *cubing* numbers, or for working *proportions wherein ſquares and cubes are concerned*, of great uſe in various parts of the mathematics. We ſhall here work a few examples. What is the ſquare root of 144? or, which is the ſame thing, what is the ſide of a ſquare whoſe area is 144 feet?—Solution—Call the 1, at the beginning of the line of numbers, marked *Numb Root*, 100, and extend the compaſſes from that point to 144, the calling the 1, at the beginning of the line of numbers, marked *Numb Root*, 10, and placing one point of the compaſſes at the 10, the other point will extend to 12, the required root.

Example 2nd. The areas of circle being as the ſquares of their circumferences, let us ſuppoſe the weight of cables of unequal circumferences, but of equal lengths, to be in the ſame proportion. On this ſuppoſition, let it be required to find the weight of a cable, whoſe circumference is 8 inches, the weight of one of equal length of 10 inches circumference being 25 hundred. Here, by the ſuppoſition, the proportion is, as the ſquare

of

10 is to the ſquare of 8, ſo is 25 to the required
eight.

To ſolve this by the ſcale, extend the compaſſes
the line *Numb Root* from 10 to 8, then on the
e *Numb Sqr.* will that extent reach from 25 to
hundred, the weight of a cable of 8 inches.

Example 3. What is the cube root of 1728? or,
hich is the ſame thing, if a cube or die contains
28 ſolid inches, what is the ſide of the cube?

This may be ſolved by a bare inſpection; for
lling the 1, at the beginning of the line *Numb*
ube, 1000, and the 1 correſponding to it, on the
e *Numb Root*, 10, then againſt 1728 on the
umb Cube, you will ſee 12 on the *Numb Root*,
e required root.

Example 4th. Suppoſe a ſhip of 300 tons to be
5 feet by the keel, it is required to find the
ngth of a keel of a ſimilar ſhip of 500 tons
rden.

Solution. *Similaa ſolids being in proportion, as*
cubes of their like ſides, we have as 300 is to
0, ſo is the cube of 75 to the cube of the re-
ired keel. Therefore, extend the compaſſes
om 300 to 500, or from 3 to 5, on the line
umb Cube, then will that ſame extent on the
e *Numb Root* reach from 75 to 891 feet, nearly
e length of the keel required.

This inſtance of a uſeful, but troubleſome queſ-
n, if ſolved by arithmetick, being ſo expedi-
uſly ſolved by the ſcale, by means of the addi-
tion

tion of theſe lines, is a ſufficient recommendatio of their uſe.

As the greater part of a ſailor's day's work may be worked by the Gunter's ſcale, to a ſufficient degree of accuracy, and in an expeditious manner, (and it is the wiſh of many to be poſſeſſed of a good ſcale, the common ſort, uſually vended, being too erroneons, even for a carpenter) it may, therefore, now be conſidered as their own faults, if they are not provided with a good and accurate ſcale.

11 JY 63

FINIS.